

of *Rhynchonella*, &c., and concluding with the following passage:—

“But let me not forget to acknowledge that I was in error in doubting the absence of perforations ‘in any Brachiopod whatever:’ the account which Dr. Carpenter has given of *Rhynchonella psittacea* in his late chapter* is quite conclusive on this point; but I cannot help thinking, from their occurring in *R. Geinitziana*†, that perforations will yet be found in congeneric species supposed, or stated, to be without them”‡.

The way Dr. Carpenter writes with reference to my voluntarily acknowledged error, also the other “remarks” he has indulged in in his letter, will, I feel assured, be quite sufficient to convince the “scientific world” that, for anything more he can adduce, the “main question” (*i. e.* the “remarkable fact incontestably established”) at issue between us is, as far as we are mutually concerned, now closed,—that, if kept open, it would inevitably degenerate into a mere personal dispute, redundant of reticences, and bolstered up with no end of irrelevant matter.

Yours very truly, &c.

WILLIAM KING.

XXI.—On the Law of Development of the Sexes in Insects.

By Professor VON SIEBOLD§.

THE assertion made by Landois in his preliminary communication¶ that the eggs laid by insects possess no definite traces of the sexual organs, and that the sex of the larvæ is only developed as male and female after their escape from the egg-shell by the influence of difference of food received from without, will not only possess the highest interest for all naturalists who attend to the reproductive history of organic bodies, but, as Landois applies this theory specially to the reproduction of

* Reference is here made to Dr. Carpenter’s memoir “On the Intimate Structure of the Shells of Brachiopoda,” appended to Mr. Davidson’s Monograph of Brit. Foss. Brachiopoda: Introduction. A perusal of my footnote will explain the reason why I only referred to Dr. Carpenter’s “late chapter.”

† The presence of perforations in this species has caused me to regard it as the type of a new genus (*Rhynchopora*) of the family Rhynchonellidæ.

‡ See Ann. & Mag. Nat. Hist. ser. 2. vol. xvii. p. 337. Even in June (Geological Magazine) of last year I again drew attention to this point, acknowledging “the mistake I made in asserting that certain imperforate Palliobranchs are perforated,” and in “concluding that all Spiriferidæ are perforated.”

§ Translated by W. S. Dallas, F.L.S., from the Zeitschrift für wissenschaft. Zoologie, Band xvii. pp. 525–532.

¶ See Zeitschrift für wiss. Zool. xvii. p. 375, and Ann. & Mag. N. H. ser. 3. vol. xix. p. 224.

bees, must also produce considerable excitement among the breeders of bees, as Landois in so many words completely denies the existence of the very peculiar parthenogenetic circumstances under which the male bees are developed from the eggs.

Landois appeals to his repeatedly successful experiments by which he thinks it is proved that all the eggs laid by a normal queen are fertilized by her, that in consequence of this fertilization the development of the larvæ in the eggs takes place, and, further, that these larvæ when just hatched from the egg do not yet possess any definite indications of sex. The sex of bees is rather [according to him] only fixed as male or female by the difference of nourishment taken from without, according as the workers furnish drone-food to those larvæ in the drone-cells, or worker-food to those in the worker-cells.

Landois transferred the bottom of a drone-cell, furnished with an egg, into a worker-cell, and *vice versâ* the egg-bearing bottom of a worker-cell into a drone-cell; and by this means from the egg destined by the queen to become a worker, the larva from which in consequence of this transfer was nourished with drone-food, he obtained a drone, whilst from the egg destined by the queen to become a drone, the larva of which in consequence of a similar substitution was brought up on worker-food, a worker was produced.

Whether no error or illusion can occur in these experiments must be decided by practised and experienced bee-keepers, to whom I particularly recommend the repetition of this experiment. For my part I can only appeal here to those results which are to be obtained by anatomical and microscopic investigations of the larvæ of insects in course of development within the egg. Taking these into consideration, I feel compelled to express the greatest doubt as to the correctness of the new theory set up by Landois.

From the very careful investigations of various reliable observers in the domain of the developmental history of insects, we know that, even in the egg, simultaneously with the development of the different systems of organs of an insect-larva, the sexual organs also begin to be formed, and even become differentiated to such a degree that in a larva which has just escaped from the egg-shell we are already able to distinguish the male or female sex from the difference in form of the first rudiments of the inner reproductive organs.

Herold, the well-known insect-anatomist, obtained the following results from his accurate investigations of the development of the cabbage-butterfly* :—The organs which

* See his 'Entwicklungsgeschichte der Schmetterlinge,' Kassel und Marburg, 1815, p. 1.

are produced by the formative power from the fluid of the egg are, a nervous system, a muscular system, an air-vessel system, and an alimentary system, together with the salivary and biliary vessels belonging to the latter,—also a pair of excretory organs (namely, the spinning-vessels), a dorsal vessel, and, lastly, the germs of undeveloped reproductive organs, with a *perfectly distinctly visible distinction of the two sexes*. On the fifth plate of the above-mentioned work he gives an exceedingly instructive and true view of the germs of the reproductive organs of both sexes, as these gradually enlarge from the first formation of the cabbage-caterpillar in the egg up to its full growth and approach to transformation. In fig. 1 he shows the two reniform corpuscles divided by three constrictions into four sections lying one behind the other (the future testes), with two filaments issuing from them laterally (the future efferent ducts), from a male caterpillar which had crept out of the egg a few hours before; whilst in fig. 2 of the same plate we may recognize the two bud-like corpuscles, with four laterally approximated sausage-like divisions and two fine filaments springing from behind, as the future ovaries and oviducts of a female caterpillar of similar age. I will not, however, conceal that Hermann Meyer, of Zurich, did not succeed* in finding the sexual parts in caterpillars which were only a few days old; on the other hand, Weismann, in his remarkable work on the embryology of insects† completely affirms the correctness of the observations first made by Herold in butterflies of the occurrence even in the embryo of the germs of the sexual glands with distinctly visible distinction of the sex, inasmuch as he could likewise distinguish the rudiments of the sexual glands in the embryos of flies in the egg, although the difference between the germs of the male and female sexual glands is much less striking. In the investigation of a Tipulide larva, however, Weismann obtained other results, which I must not pass over. When he sought the genital glands in the embryos of *Corethra plumicornis*‡, he certainly convinced himself that in this insect also, as in the larvæ of the true flies, the sexual glands are already traced out in the embryo; but he found that in the larvæ of *Corethra* just escaped from the egg the distinction is as yet by no means clear, and this distinction does not make its

* "Ueber die Entwicklung des Fettkörpers, der Tracheen und der keimbereitenden Geschlechtstheile bei den Lepidopteren," Zeitsch. für wiss. Zool. Bd. i. p. 177.

† "Die nachembryonale. Entwicklung der Musciden nach Beobachtungen an *Musca vomitoria* und *Sarcophaga carnaria*," *ibid.* Bd. xiv. p. 219.

‡ Die Metamorphose der *Corethra plumicornis*, *ibid.* Bd. xvi. p. 99.

appearance in a marked manner until after the fourth change of skin. From Mecznikow's very accurate embryological investigations on insects, it appears also that although the tracing out of the sexual glands takes place very early in all embryos of insects, their further development does not advance at an equal rate in all such embryos; so that it is only in certain insects that the differentiation of the sexual organs occurs very early, and, indeed, already in the embryo, whilst in other insects, on the contrary, it is postponed, and takes place only in the excluded larvæ. In the very young larvæ of *Simulia*, just escaped from the egg, Mecznikow* observed a small round genital rudiment, and concluded from this that the rudiments of the sexual organs are formed in the larvæ within the egg. The same author recognized, even at the first formation of the embryo in the viviparous Aphides, the first rudiments of the sexual apparatus as the so-called genital hill†. During the further development of the embryo, and indeed very early, this genital rudiment becomes differentiated into ovarian tubes, in which so-called *pseudova* are likewise very soon developed; so that even during the embryonal life of the aphis-embryo the development of the new generation commences, and goes so far that in the embryos ready to be born two germ-chambers occur in each ovarian tube, of which the lowest already encloses an embryo in the first stage of its development‡. In *Aspidiotus Nerii*, on the contrary, Mecznikow§ could not find any genital hill so early produced and differentiated into ovarian tubes, such as he had succeeded in discovering in the Aphides.

From these known circumstances in the first development of the reproductive organs of insects it appears that differences occur in it, and that in a certain series of insects the differentiation of the sexual apparatus occurs in the embryos while still enclosed in the egg-shell, whilst in other insects this differentiation only takes place after the exclusion of the larvæ. Landois's theory can certainly find no application to the insects belonging to the first series—namely, the Lepidoptera and Flies (*Muscidæ*); in the second series, in which *Corethra*, *Simulia*, and *Aspidiotus* are to be placed, it may be possible that the still rudimentary and indifferent sexual glands of the larvæ are further developed in accordance with the male or female type, under the influence of the incepted nourishment. When, and in what manner in the larvæ of the bees the first

* "Embryologische Studien an Insecten," Zeitsch. für wiss. Zool. Bd. xvi. p. 405.

† Ibid. p. 444, pls. 28 and 31. figs. 15–37, and p. 458.

‡ Ibid. p. 459, pl. 31. fig. 46.

§ Ibid. p. 473.

rudiments and the definite differentiation of the sexual glands appear, we have no direct investigation to show. I earnestly recommend such investigation to entomologists for the solution of the question before us. Leuckart, however, has already given an indication in this direction *, when he says, "on the sixth day I find in the female larvæ the first traces of internal genitalia."

With regard to the above-mentioned discovery of Meczni-kow's, of the development in the embryos of the viviparous Aphides of ovaries in the germ-chambers of which the formation of a new generation was already commenced, M. Landois has informed me, by letter under date of the 6th May, that he has succeeded by the gradual application of artificial cold, and during the withering of their food-plants, to cause the disappearance of the viviparous Aphides (the so-called *Nurses*), and the appearance in their place of the sexual generation consisting of males and ovipositing females. I cannot doubt this result which Landois has obtained from his experiments; but I will take the liberty of putting the question, How, in this case, does the production of the two sexes simultaneously with the existence of scanty nourishment agree with the new theory set up by Landois?

From his experiments on bees, Landois draws the conclusion that the development of female and male bees is induced, independent of the fecundation or non-fecundation of the ova, only by difference of the food supplied to the larvæ—abundant nourishment producing females, and scanty nourishment males. According to the observations and statements of our most experienced observers of bee-life, this opinion, expressed by Landois as to the different feeding of the larvæ of bees, is not correct. All writers who have treated of the rational management of bees agree in this, that the *whole of the larvæ* in the earliest period of their life (up to the sixth day) receive the *same nutriment*, namely, food-paste (digested chyle-paste), with which the larvæ destined to become queens are fed, abundantly and uninterruptedly, until their change to the pupa state; whilst the *larvæ of the workers and drones* afterwards (from the sixth day) receive, instead of chyle-paste, a coarser sort of food prepared from undigested honey and pollen †.

* *Bienenzeitung*, 1865, p. 210.

† To indicate only a few of the many authorities who have expressed themselves concordantly as above with regard to the feeding of the larvæ of bees, I cite the following:—

Leuckart: "Ueber die Nahrung der Bienen im ausgebildeten Zustande und während des Larvenlebens," *Bienenzeitung*, 1855, p. 207.

Berlepsch: 'Die Biene und die Bienenzucht,' 1860, p. 102.

Klein: 'Die Biene und ihre Zucht,' 1864, p. 29.

This identity of the nourishment of the young brood of the workers and drones seems to have been entirely overlooked by Landois. A difference between the food of the drones and workers, such as Landois lays so much stress upon, does not exist. As, from the observations of our most experienced breeders of bees, the workers are able to rear a queen from a worker larva before it is six days old, and as the workers can, by means of royal food, procure a queen from every egg normally deposited in a worker-cell, but not from an egg normally deposited in a drone-cell, it follows, as a matter of course, that in bees the sex is definitely fixed beforehand even in the egg by the effectuation or omission of fecundation, and not merely defined by the difference of the food of the larva.

The development of the eggs laid by unfertilized queens, from which, according to the experience of all observant bee-keepers, only drones are produced, is not regarded as parthenogenesis by Landois; at least the term "parthenogenesis" is avoided by him, although he speaks of a primary and a secondary drone-broodedness, the cause of which is thus explained by him: "that eggs are laid by queens or workers, which are furnished with *scanty formative materials*, from which *weakly larvæ* must be developed, and consequently drones."

Whence does Landois conclude that these eggs laid by drone-brooded queens and workers are furnished only with scanty formative materials? By what investigation has Landois arrived at the knowledge that from such eggs weakly larvæ, and consequently drones, must be developed? Has Landois convinced himself by careful observation and exact dissection of such drone-mothers of the absence of male semen in their sexual organs? Our scientific bee-keepers could state with regard to a great number of drone-brooded queens, with certainty, that they had remained unfecundated, and that they consequently laid unfertilized eggs, but, as experience has proved, capable of development, from which, whether deposited in drone- or worker-cells, only drones are developed. The dissection of such drone-mothers, which has been often enough undertaken by people well acquainted with the subject, has always proved that the seminal receptacle, whether normally developed or rudimentary, contained no trace of male semen.

As Landois refers to the fact that, with regard to the proposition that "drones always proceed from unfertilized eggs,"

Schmid und Klein, 'Leitfaden für den Unterricht in Theorie und Praxis einer rationellen Bienenzucht,' 1865, p. 26.

Vogel, 'Praktisches Handbuch der Bienenzucht,' 1866, p. 99.

Dzierzon himself doubted his own theory, because, in the experiments on intercrossing German and Italian bees, remarkable and inexplicable phenomena occurred which could not be brought into harmony with Dzierzon's theory, I must appeal to the arguments which I have already urged against this doubt of Dzierzon's*.

Landois states that by taking very young larvæ of *Vanessa urtica* and feeding them imperfectly he reared from them only males, and by feeding them abundantly only females. This assertion is in complete contradiction to the phenomenon which may be observed in *Polistes gallica* with regard to the production of the sexes. Every female of *Polistes* fecundated in the autumn, after passing through its winter-sleep, founds a separate colony at the commencement of the spring; it makes a comb for itself, furnishes the cells of this with eggs, and then, still quite alone, feeds the larvæ produced from these eggs until they are full-grown. From these larvæ the so-called workers (that is to say, small female individuals) are always developed; male individuals are never bred in the months of June and July; and it is only in August that the first males issue from the operculated cells of these colonies of *Polistes*. According to Landois's theory, the larvæ reared by the solitary *Polistes* mother ought to furnish males, as this brood is usually very scantily provided with nourishment, and indeed often left for a considerable time without food by their mother, which has to complete the business of feeding them without any assistance. This starvation of the brood of *Polistes* occurs when the temperature becomes cold, when the sky is overcast, and during rain and wind; for when the weather is unfavourable, even if this lasts for several days, the females of *Polistes* remain uninterruptedly inactive, concealed behind their combs. As no supply of food is laid up in the combs of *Polistes*, but the nourishment is always poured from mouth to mouth by the Wasp into the larvæ, the scarcity of food often causes the development and growth of the larvæ to go on very slowly and with interruptions. According to Landois, all these circumstances ought especially to favour the development of male individuals; but until a large number of workers (which, as larvæ, certainly do not revel in a superabundance of food) have been excluded to assist the mother, no male individuals of *Polistes* are developed.

In order to give more currency to the assertion that in those insects the larvæ of which are developed in their food a disproportionate number of females are developed, Landois refers

* Wahre Parthenogenesis bei Schmetterlingen und Bienen, 1856, p. 92. (English translation, p. 74.)

amongst other instances, to a great number of Dipterous genera the larvæ of which wallow in the excess of their food, and mentions that, out of 403 species of these Diptera, Meigen knew only the females of 255. But these examples cannot be adduced as in the least in favour of Landois's theory; for Meigen, in his well-known 'Systematische Beschreibung der europäischen zweiflügeligen Insekten,' very frequently, by his own admission, had only a *single* female and also very often only a *single* male in his hands as the type of the descriptions of his species. Such scanty material as this is certainly insufficient to prove the predominance of one sex over the other.

XXII.—On some new Species of Oliva.

By F. P. MARRAT.

IN selecting the following shells and describing them as new species, I have been guided principally by prominent features in each case, that, in my opinion, warrant the selection and publication.

Oliva lignaria, Marrat, is very remarkable: at one time I supposed it might be a variety of *O. inflata*, Lam.; at another its resemblance to *O. maura*, Lam., appeared to be considerable; and at a third it was, until compared, thought to be a variety of *O. irisans*, Lam. It may prove to be a variety of any one of these three shells when specimens are obtained showing the gradual variation; but at present a shell possessing such connecting characters is still to be brought under notice.

O. sabulosa, Marrat.—The specimens of this shell are described as having red-brown markings. I think, in most if not in all cases, the original colour has been dark brown, and that bleaching in the sun has produced the red-brown colour, notwithstanding one of the shells is brilliantly polished and possesses all the appearance of a dredged shell.

I am much surprised that a shell of rather common occurrence and so decidedly distinct as *O. angustata*, Marrat, should have remained so long unnoticed by conchologists. Years ago its form was familiar to me among the shells imported in the boxes from China.

1. *Oliva lignaria*, Marrat.

Shell cylindrically oblong; spire depressed, callous; suture-edge dotted; colour drab, with dark-brown interrupted bands and angular lines, shaded with purplish spots and dotted lines; the whole interior of the aperture of a uniform purple brown; folds very prominent, one or two tinged